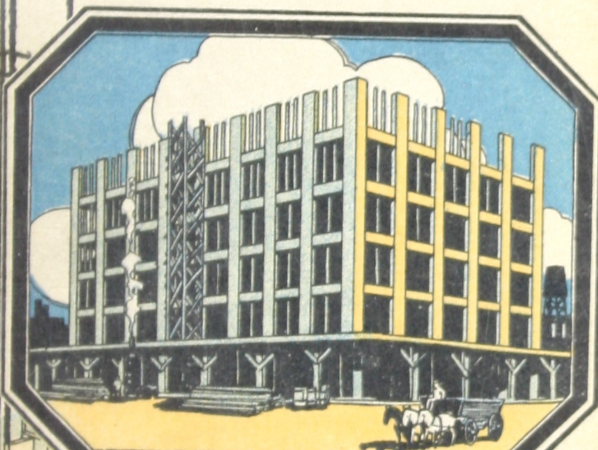
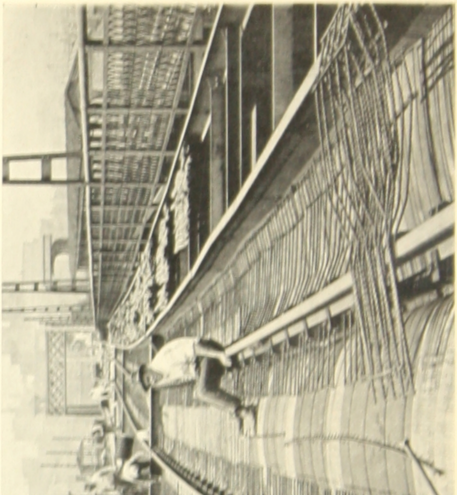
CAMBRIA
Slick Concrete Reinforcing Bars



CAMBRIA STEEL COMPANY
General Sales Office - Widener Building - Philadelphia
Works - Johnstown, Pa.

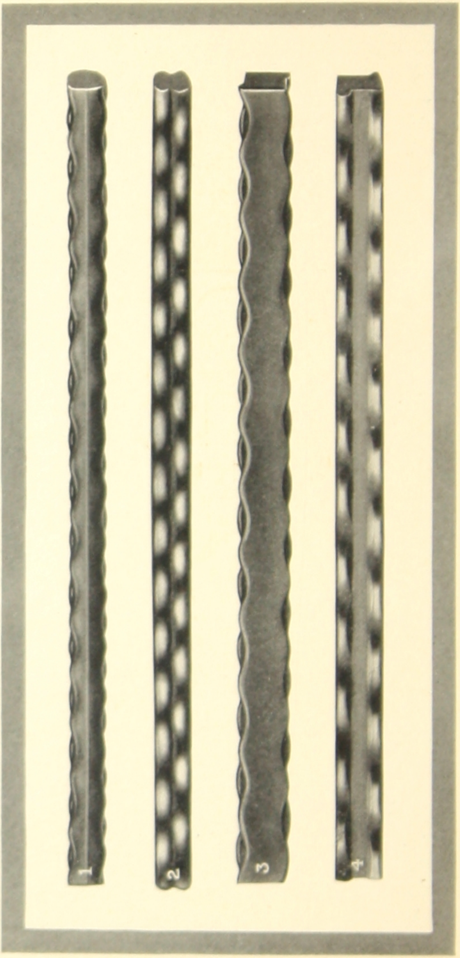


ST. LOUIS MUNICIPAL BRIDGE

Showing Slick Concrete Reinforcing Bars Being Placed in Position

CAMBRIA
Slick Concrete Reinforcing Bars

CAMBRIA STEEL COMPANY
General Sales Office-Widener Building, Philadelphia
Works – Johnstown, Pa.



TYPES OF SLICK CONCRETE REINFORCING BARS

1 AND 2, ROUND SECTION BAR. Patented March 17, 1908 3 AND 4, SQUARE SECTION BAR. Patented March 17, 1908

CAMBRIA SLICK CONCRETE REINFORCING BARS

GENERAL DESCRIPTION

SLICK Concrete Reinforcing Bars are of substantially uniform cross-section throughout and are consequently of equal strength at all places, so that the material is economically distributed to best advantage.

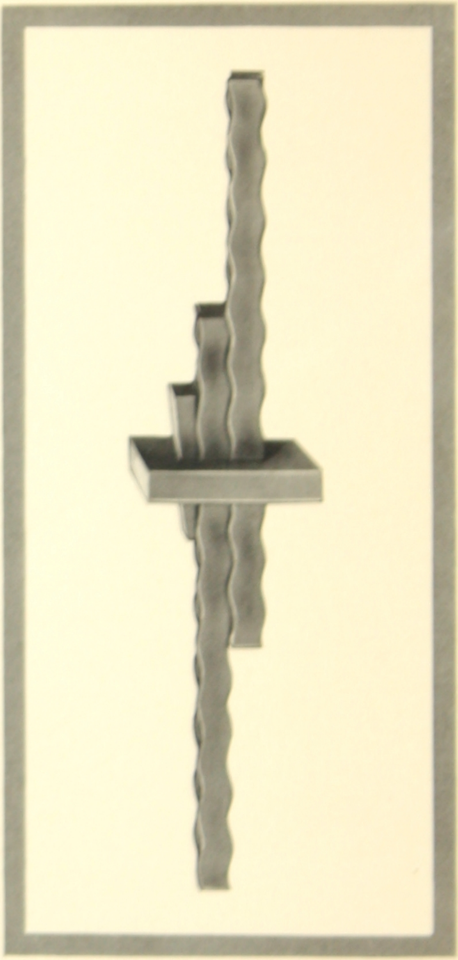
The projections on these bars are arranged in the form of undulations or waves and are so located that the concrete can be firmly bedded on all portions of the bar without the possibility of the formation of air pockets which would destroy the contact.

POINTS OF SUPERIORITY

THE Slick bar is the only one of all the deformed bars in the market which can be positively spliced, so as to be equal in strength to the bar; whereas all other bars are merely spliced by overlapping; these latter depending upon the concrete for their strength instead of on the steel, as it should be.

With other forms of bars it is customary to provide a lap in cases where they have to be spliced, this lap being equal to about forty diameters of the bar.

On the other hand, Slick bars are so arranged that their surfaces will interlock by merely



SLICK WEDGE CLAMP JOINT. Patented September 1, 1914
CHEAPER TO USE, EASIER TO MAKE, AND STRONGER THAN WIRED JOINTS

placing them in contact with each other and an overlap of the length of five waves or undulations together with the wedge clamp will develop a strength at the splice equal to that of the bar, as determined by actual pulling tests. By reason of this method of splicing a lesser amount of lineal feet of bars will suffice, and in cases where extreme lengths are used in excess of carload or twin carload lengths (60 feet), bars can be spliced to their full strengths by means of the clamps and wedges to give any length desired.

REDUCED COST WITH SLICK BARS AND CLAMP JOINT

THE Slick Wedge Clamp Joint, with its greatly decreased lap as compared with the usual lap of forty diameters, provides a large reduction in the weight and cost of the bar material, and the freight and haulage charges thereon. The item of wire for binding the lapped ends of the bars is entirely eliminated, while the time, labor, and cost in clamping the joint with the Slick Clamp and Wedge are but a fraction of those required by the ordinary wire tie method.

The total cost, all things considered, namely: amount of lap, time, labor, and wire material for tying in accordance with the old method; and, on the other hand, the material of the Slick Clamps and Wedges, with the less time, labor, and lap to install them, make the Slick Clamp and Wedge Method the cheaper and better construction, besides giving a positive joint; whereas the old style joint is not positive and depends on the concrete for its strength.

USE AND ARRANGEMENT OF REINFORCING BARS

IN FLOOR slabs, retaining walls and similar constructions generally, the principal point is to obtain a certain cross-sectional area of steel to withstand the tensional stresses, and this may be done by using more or less bars spaced at shorter or longer distances apart, so that the question of the size of any one bar, within the limits furnished, does not really enter into the matter. To put this more simply, if 10 square inches of cross-section are desired, this could be obtained by 10 bars, each 1 inch square, or 18 bars, each 3/4 inch square, or 40 bars, each 1/2 inch square, etc.

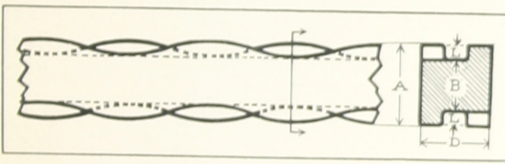
For beams and girders, however, the number of bars is limited to a certain extent, but a careful designer could use, for example, three Slick square bars, two of them being of a different size from the third, and in such a manner as to obtain practically any cross-section desired. In addition to this there are hundreds of methods and formulæ for the calculation of stresses in reinforcing steel for concrete structures, and the whole matter is not a well-defined art.

The main essential in using reinforcing bars is to have a certain cross-section, and this may be made by any suitable combination of sizes, or by using a suitable number of bars, and arranging the spacing in such a way that the required cross-section of steel is obtained.

WEIGHTS AND DIMENSIONS—SQUARE BARS

THE sizes, areas and dimensions of the square Slick bars, in comparison with standard square bars, are given in the following table:

COMPARATIVE AREAS AND WEIGHTS OF SLICK REINFORCING BAR AND STANDARD SQUARE BAR



Patented March 17, 1908 Section

APPROXIMATE AREAS AND WEIGHTS ALL DIMENSIONS IN INCHES

SLICK REINFORCING BAR SQUARE TYPE								STANDARD SQUARE BAR	
Section Number	Size of Bar	D	A	B	L	Area Square Inches	Wght. Lbs. Per Ft	Area Square Inches	Weight Pounds Per Foot
M-395	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{43}{128}$	$\frac{27}{128}$	$\frac{1}{16}$	.063	.21	.0625	.212
M-396	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{32}$	.141	.48	.1406	.478
M-397	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{85}{128}$	$\frac{55}{128}$	$\frac{15}{128}$	.250	.85	.2500	.850
M-398	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{103}{128}$	$\frac{69}{128}$	$\frac{17}{128}$	.391	1.33	.3906	1.328
M-399	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{123}{128}$	$\frac{83}{128}$	$\frac{5}{32}$	.563	1.91	.5625	1.913
M-400	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{7}{64}$	$\frac{49}{64}$	$\frac{11}{64}$	.766	2.60	.7656	2.603
M-401	1	1	$1\frac{35}{128}$	$\frac{111}{128}$	$\frac{13}{64}$	1.000	3.40	1.0000	3.400
M-402	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{55}{128}$	$\frac{125}{128}$	$\frac{29}{128}$	1.266	4.30	1.2656	4.303
M-403	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{37}{64}$	$1\frac{3}{32}$	$\frac{31}{128}$	1.563	5.31	1.5625	5.313
M-101	$\frac{3}{4}$x$\frac{1}{4}$	$\frac{3}{4}$	$\frac{9}{16}$	$\frac{1}{4}$	$\frac{5}{32}$	0.282	0.96	Special Bar	

Maximum Length, 60 feet

It should also be understood that the $\frac{3}{4}$ inch square Slick bar is substantially equal to a $\frac{7}{8}$ inch plain round, and a $\frac{7}{8}$ inch square Slick bar is about equal to a 1 inch plain round, and a 1 inch square Slick bar almost exactly equal to a $1\frac{1}{8}$ inch plain round.

The only advantage that the Slick bars equal in section to round bars might have is in cases where an engineer has his drawings made for round bars, when the Slick bars of a similar cross-section can be provided, in such a way that the engineer or architect will not have to change his spacing of rods in order to provide the cross-section.

BONDING SURFACE OF CONTACT

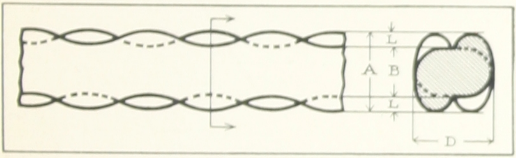
A SQUARE bar is a better reinforcing bar than a round one for the reason that the area of contact of a square bar with the concrete in which it is embedded is much greater than that of a round one. A round bar gives the least possible surface of contact, and a greater contact is obtained the further we depart from the round or circular form.

For example, a 1 inch plain square bar has a circumference of 4 inches and an area of 1 square inch, whereas a round bar of approximately $1\frac{1}{8}$ inch diameter has a cross-section of about 1 square inch, but is only $3\frac{1}{2}$ inches in circumference, so that the square bar has about 14 per cent. more contact surface, the cross-sections being of equal area.

WEIGHTS AND DIMENSIONS OF SLICK ROUND DEFORMED BARS

TO MEET the requirements of those who prefer a bar of round section, we roll a complete series of Slick bars of this form, as shown below:

COMPARATIVE AREAS AND WEIGHTS OF SLICK ROUND SECTION REINFORCING BAR AND STANDARD ROUND BAR



Patented March 17, 1908 — Section

APPROXIMATE AREAS AND WEIGHTS
ALL DIMENSIONS IN INCHES

SLICK REINFORCING BARS ROUND TYPE								STANDARD ROUND BAR	
Section Number	Nominal Size	D	A	B	L	Area Square Inches	Weight Pounds Per Foot	Area Square Inches	Weight Pounds Per Foot
M-494	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{9}{32}$	$\frac{5}{32}$	$\frac{1}{16}$	.049	.17	.0491	.167
M-495	$\frac{3}{8}$	$\frac{27}{64}$	$\frac{27}{64}$	$\frac{15}{64}$	$\frac{3}{32}$	.110	.38	.1104	.376
M-496	$\frac{1}{2}$	$\frac{35}{64}$	$\frac{35}{64}$	$\frac{5}{16}$	$\frac{15}{128}$	.196	.67	.1963	.668
M-497	$\frac{5}{8}$	$\frac{43}{64}$	$\frac{43}{64}$	$\frac{13}{32}$	$\frac{17}{128}$	.307	1.04	.3068	1.043
M-498	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{1}{2}$	$\frac{5}{32}$	.442	1.50	.4418	1.502
M-499	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{19}{32}$	$\frac{11}{64}$	.601	2.04	.6013	2.044
M-500	1	$1\frac{1}{16}$	$1\frac{3}{32}$	$\frac{11}{16}$	$\frac{13}{64}$	.785	2.67	.7854	2.670
M-501	$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{15}{64}$	$\frac{25}{32}$	$\frac{29}{128}$	.994	3.38	.9940	3.380
M-502	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{23}{64}$	$\frac{7}{8}$	$\frac{31}{128}$	1.227	4.17	1.2272	4.172

Maximum Length, 60 feet

Cambria Slick Concrete Reinforcing Bars

The round Slick deformed bars may be used by engineers, architects, contractors and builders who prefer this section and, in cases where required, these bars may be spliced with clamps and wedges in the same manner as the Slick square sections and with equally good results as regards strength and economy.

These round deformed bars can be directly substituted in all cases where the design has been made for the ordinary plain round bars without any changes whatsoever in the arrangement or dimensions.

The undulating form of the projections and depressions in the Slick round bars adds to the surface in contact with the concrete, in addition to providing positive bond with the concrete by reason of the deformations.

The Slick round bars will meet the most rigorous tests, and either the square or round bars may be selected by the user with equally satisfactory results.

RESULTS OF ACTUAL TESTS OF SLICK JOINTS

IN ORDER to determine the strength of the clamps and wedges many tests have been made of the bare bars and clamps and wedges, which were pulled on a standard Riehle testing machine, the results in general being represented by the following:

CAMBRIA STEEL CO.—DEPT. OF TESTS
CAMBRIA PHYSICAL TESTING LABORATORY

TENSILE TEST REPORT

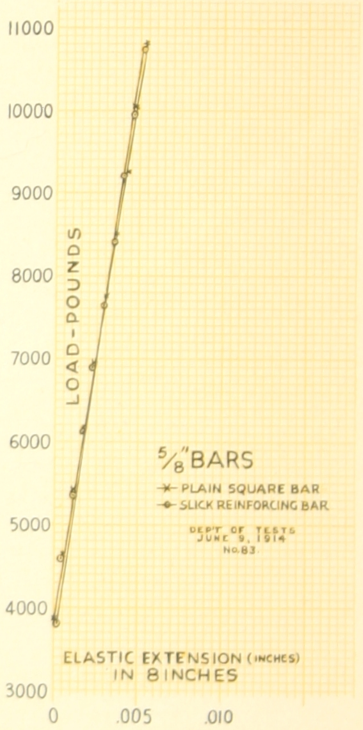
Slick Reinforcing Bars, equipped with clamps and wedges

SPECIMEN	Area	Ultimate Load Lbs.	Ultimate Strength Lbs. per Sq. In.	REMARKS
½ inch Slick Bars	.251	16,020	63,800	Grade—Structural Steel.
⅝ inch Slick Bars	.382	22,400	58,640	Length of Lap—5 corrugations in each case.
⅝ inch Slick Bars	.382	22,800	59,690	

NOTE.—Specimens broke in the body of the bars, the clamp and wedge in every case being intact after the rupture of the bar.

While in actual use the bars are surrounded by solid concrete and, dependent upon the design, are stressed from 15,000 pounds per square inch to 18,000 pounds per square inch, which is only one-fourth of that to which they are subjected when broken with the clamps in testing machine. When the bars and clamps were tested in the machine they were bare, while in use they are surrounded by solid concrete, which will add possibly 50 per cent. or a great deal more to the strength of the splice. This indicates that the splice, when embedded in concrete, is from six to ten times as strong as any stress to which it will be subjected.

DIAGRAM OF ELASTIC EXTENSION
SLICK BAR AND PLAIN
SQUARE BAR



EVERY PART OF THE SLICK BAR RESISTS THE STRESSES OF USE

IN THE economical design of bars of this character, it is well to bear in mind that the material should be so arranged that it is all effective to resist the stresses to which it will be subjected, while at the same time, a deformed bar should have irregularities sufficient to provide a bond between it and the concrete which surrounds it. Tests have been made of the Slick bar in comparison with similar sizes of square bars, to determine their qualities in these respects.

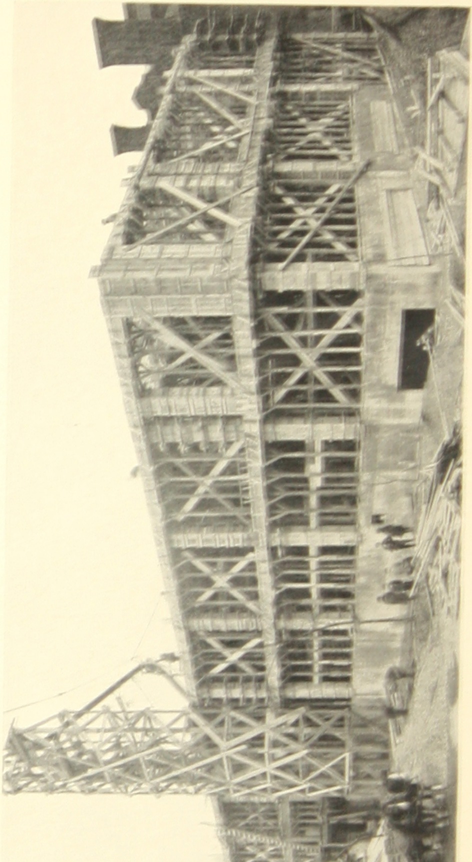
The diagram on the opposite page shows by comparison that the extensions under tensile tests of bare bars, within the elastic limit of a $\frac{5}{8}$ inch Slick bar and a $\frac{5}{8}$ inch plain square bar, are equal, and if anything, the Slick bar is better toward the higher limits.

This diagram shows the amount of elastic extension in tension for increments of load of 1000 pounds, and clearly indicates that the undulating form of the Slick bar is such that every part of this section is doing its share of the work when subjected to the stresses of use.

In other words, the shape and contour of the Slick bar are such that, in use, the projections, as well as the body of the bar, resist the stresses, and each and every part is as good as a plain bar for resisting pull.

BOND TESTS

TESTS have also been made of the strength of the bond between Slick bars and the concrete surrounding them, in comparison with other bars, and it has been found that the Slick bars, when embedded to a depth of sixteen times their nominal diameters, viz.:



WOLVERINE SUPPLY AND MANUFACTURING COMPANY BUILDING
PITTSBURGH, PA.

8 inches for a ½ inch bar
10 inches for a ⅝ inch bar
12 inches for a ¾ inch bar, etc.,

all broke outside of the concrete when pulled in tension, whereas other bars and plain bars for this depth of embedment, would pull out of the concrete without breaking the steel. This indicates that the bonding effect between concrete and steel is well taken care of by the form and construction of the bars in question.

In this connection test results obtained by independent engineers and our own laboratory staff, which follow, will be found exceedingly interesting.

BOND TESTS OF SLICK CONCRETE REINFORCING BARS

MADE BY INDEPENDENT ENGINEER

Size of Slick Bar Inch	Size of Concrete Block Inches	Embed'd Depth of Bar Inches	Load at Initial Slip Pounds	Load at Failure Pounds	Rod at Failure	Block at Failure
1	12x12	30	No slip	72,120	Broke	
1	12x12	30	No slip	72,850	Broke	Small
1	12x12	30	No slip	72,250	Broke	Cracks
1	12x12	25	56,000	72,300	Broke	Split
1	12x12	25	60,000	71,950		Split
1	12x12	25	60,100	71,250	Did	Split
1	12x12	20	51,350	61,530	Not	Split
1	12x12	20	47,150	66,920	Break	Split
1	12x12	20	48,000	68,340		Split
½	8x8	18	No slip	14,880	Broke	O. K.
½	8x8	18	No slip	14,670	Broke	O. K.
½	8x8	18	No slip	14,540	Broke	O. K.
½	8x8	12	No slip	14,580	Broke	O. K.
½	8x8	12	No slip	14,830	Broke	O. K.
½	8x8	12	No slip	14,750	Broke	O. K.
½	8x8	6	8,500	13,390	Pulled Out	O. K.
½	8x8	6	9,690	9,710	Did Not	Split
½	8x8	6	8,000	10,200	Break	Split

Cambria Slick Concrete Reinforcing Bars

BOND TESTS OF CONCRETE REINFORCING BARS

MADE BY INDEPENDENT ENGINEER

Size of Bar Inch	Type of Bar	Embedment in 8-inch Concrete Cylinder Inches	Bond Stress at Initial Slip Lbs. per Sq. In.	Maximum Bond Stress Developed Lbs. per Sq. In.	Failure
½	Plain Square	3.92	172	286	Bar Pulled Out
½	Plain Square	3.76	226	282	
½	Plain Square	4.16	152	428	
½	Plain Square	4.12	165	502	
½	Plain Square	4.00	113	425	
½	Square Slick	3.80	167	535	Block Split
½	Square Slick	3.78	247	558	
½	Square Slick	4.00	167	608	
½	Square Slick	3.90	106	345	
½	Square Slick	3.87	133	465	
¾	Plain Square	5.47	189	334	Bar Pulled Out
¾	Plain Square	5.78	113	236	
¾	Plain Square	5.80	132	245	
¾	Plain Square	6.02	108	255	
¾	Plain Square	6.02	137	244	
¾	Square Slick	5.80	290	538	Block Split
¾	Square Slick	6.00	258	691	
¾	Square Slick	6.00	270	514	
¾	Square Slick	5.57	304	482	
¾	Square Slick	5.53	174	375	
¾	Round Slick	6.09	222	441	
¾	Round Slick	6.05	94	458	
¾	Round Slick	6.10	133	598	
¾	Round Slick	6.07	135	435	
¾	Round Slick	5.95	146	630	
¾	Round Slick	6.06	111	751	
¾	Round Slick	5.84	332	698	
¾	Round Slick	6.20	153	618	
¾	Round Slick	6.10	198	670	
¾	Round Slick	6.05	189	504	
1	Plain Square	7.95	218	420	*B. C.
1	Plain Square	7.93	210	452	*B. C.
1	Plain Square	7.95	116	414	Bar Pulled Out
1	Plain Square	8.00	188	367	
1	Plain Square	8.00	172	294	
1	Square Slick	8.00	218	540	Block Split
1	Square Slick	7.90	135	456	
1	Square Slick	7.92	129	390	
1	Square Slick	8.00	233	449	
1	Square Slick	7.98	168	458	

*Block cracked shortly after maximum load was reached.

Concrete, 1 : 2 : 4 mixture, cement, sand and gravel; age, 61 days. The following is quoted from the Report on the above tests:

"The maximum loads developed by the Slick bars were higher than those developed by the corresponding plain bars, the additional strength varying in average amount from 18 to 98 per cent. The maximum load for the Slick bars was limited by the strength of the 8-inch cylinders to resist splitting action. It will be noted that all specimens with Slick bars broke by splitting of the test piece. In no case was the steel stressed to its elastic limit."

BOND TESTS OF CONCRETE REINFORCING BARS
CAMBRIA PHYSICAL TESTING LABORATORY

Embedded Depth of Bar Inches	½-IN. SLICK BARS		½-IN. PLAIN SQ. BARS		½-IN. PLAIN ROUND BARS	
	Load Pounds	Failure	Load Pounds	Failure	Load Pounds	Failure
8	16.340	Bars	11,330	Bars	8,760	Bars
10	16,130	broke	12,600	pulled	8,700	pulled
12	16,760	4½ to	12,270	out	8,750	out
18	16,600	10	12.450		9,050	
24	16,710	inches	12,440		9,420	
30	16,450	out-	13,140		9,960	
18 (wired)	16,270	side of				
18 (wired)	15,880	block.				
18 (clamped)	16,110					
18 (clamped)	16,580					

The following tests were made on $\frac{3}{8}$ and $\frac{1}{2}$ inch Slick bars embedded in $4\frac{3}{4}$ x 12 inch concrete slabs, the center line of bar being located about $1\frac{1}{2}$ inches from the side of slab. Concrete 1 : 2 : 4 mixture, 70 days old.

All the bonds developed the full strength of the bar, and the samples after testing showed no sign of bond slipping or cracking of the concrete mass.

Test No.	Size of Slick Bar Inch	Distance from Side of Slab Inches	Depth of Embedment, Bar in Slab Inches	Load at Failure Pounds	Failure Bar Broke Inches, Outside Slab
1	$\frac{3}{8}$	$1\frac{1}{2}$	$11\frac{3}{4}$	8,560	$6\frac{3}{4}$
2	$\frac{3}{8}$	$1\frac{3}{4}$	$11\frac{3}{4}$	8,690	$7\frac{3}{4}$
3	$\frac{3}{8}$	$1\frac{9}{16}$	$11\frac{5}{8}$	8,670	$8\frac{1}{2}$
4	$\frac{3}{8}$	$1\frac{9}{16}$	$11\frac{1}{2}$	8,670	$6\frac{1}{2}$
5	$\frac{1}{2}$	$1\frac{5}{8}$	$11\frac{3}{4}$	14,600	11
6	$\frac{1}{2}$	$1\frac{1}{2}$	$11\frac{1}{2}$	14,600	7
7	$\frac{1}{2}$	$1\frac{1}{2}$	$11\frac{3}{4}$	14,600	6
8	$\frac{1}{2}$	$1\frac{1}{2}$	$11\frac{3}{4}$	14,600	14

GRADES AND QUALITY OF SLICK BARS

THESE bars are made to standard specifications of either structural steel grade, intermediate grade, or of the hard grade.

On account of the fact that the Slick bars are substantially of uniform cross-section, the structural steel grade bars may be bent where necessary, as customary in this class of work.

Due consideration of the question of reinforcing bars leads to the opinion that those for use in reinforcing concrete should be initially of composition and physical properties similar to standard structural steel for buildings. Bars of these qualities when stressed from 15,000 to 18,000 pounds per square inch, act more harmoniously with the concrete, as, under these conditions, the elastic stretch of the steel will not break the bond between the bars and the

concrete to so great an extent as in the case of harder bars of high elastic limit, if used for greater working stresses.

The reason for this is that the moduli of elasticity of soft steel and hard steel are practically the same, so that the elastic stretch of the latter would be greater under higher loads with the consequent destructive effect on the bond between the steel and the concrete. The use of structural grade steels and stresses is, therefore, to be preferred for this purpose.

Cambria Slick Concrete Reinforcing Bars and Clamps are made by the Cambria Steel Company exclusively, under patents to E. E. Slick, Vice President and General Manager.

FROM 0.0005 POUND TO 400,000 POUNDS

A FINE wire nail weighing $\frac{1}{2000}$ pound and a gigantic steel casting weighing 200 tons represent two extremes which clearly convey an idea of the wide range of steel products manufactured by

MIDVALE STEEL AND ORDNANCE COMPANY

CAMBRIA STEEL COMPANY

GENERAL SALES OFFICE

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- Cold Rolled and Cold Drawn Steel
- Crank Pins and Piston Rods
- Forgings, All Kinds
- Flanged and Dished Heads
- Heavy Guns and their Mounts
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- Machine Bolts
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- Pressed Steel Seats for Agricultural Implements
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- Rifle Barrel Steel
- Rivets
- Slick Steel Mine Ties
- Stamp Shoes and Dies
- Steel Tired and Rolled Steel Wheels
- Structural Steel Work
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- Steel Discs
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CAMBRIA STEEL COMPANY

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PHILADELPHIA—WIDENER BUILDING

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DETROIT	PENOBSCOT BUILDING
NEW YORK	165 BROADWAY
PHILADELPHIA	WIDENER BUILDING
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